

## **USER'S GUIDE**

Installation & Operation  
Instructions

Doppler Flow Meter

Model DFM 5.1

Manual Series A.1

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*IMPORTANT NOTE: This instrument is manufactured and calibrated to meet product specifications. Please read this manual carefully before installation and operation. Any unauthorized repairs or modifications may result in a suspension of the warranty.*

*If this product is not used as specified by the manufacturer, protection may be impaired.*

*Available in Adobe Acrobat pdf format*

**CONNECTIONS:**

POWER INPUT: The standard model requires AC power input between 100 to 240 VAC 50/60Hz . No adjustments are necessary for voltages within this range. Connect L (Live) N (Neutral) and AC Ground.

Optional DC input model requires 9-32 VDC/9 Watts. Connect to + and - terminals.

Optional Thermostat and Heater modules are available rated for 115 VAC or 230 VAC.

IMPORTANT NOTE: To comply with CSA/UL electrical safety standards, AC power input and relay connection wires must have conduit entry to the instrument enclosure. Installation requires a switch, overcurrent fuse or circuit breaker in the building (in close proximity to the equipment) that is marked as the disconnect switch.

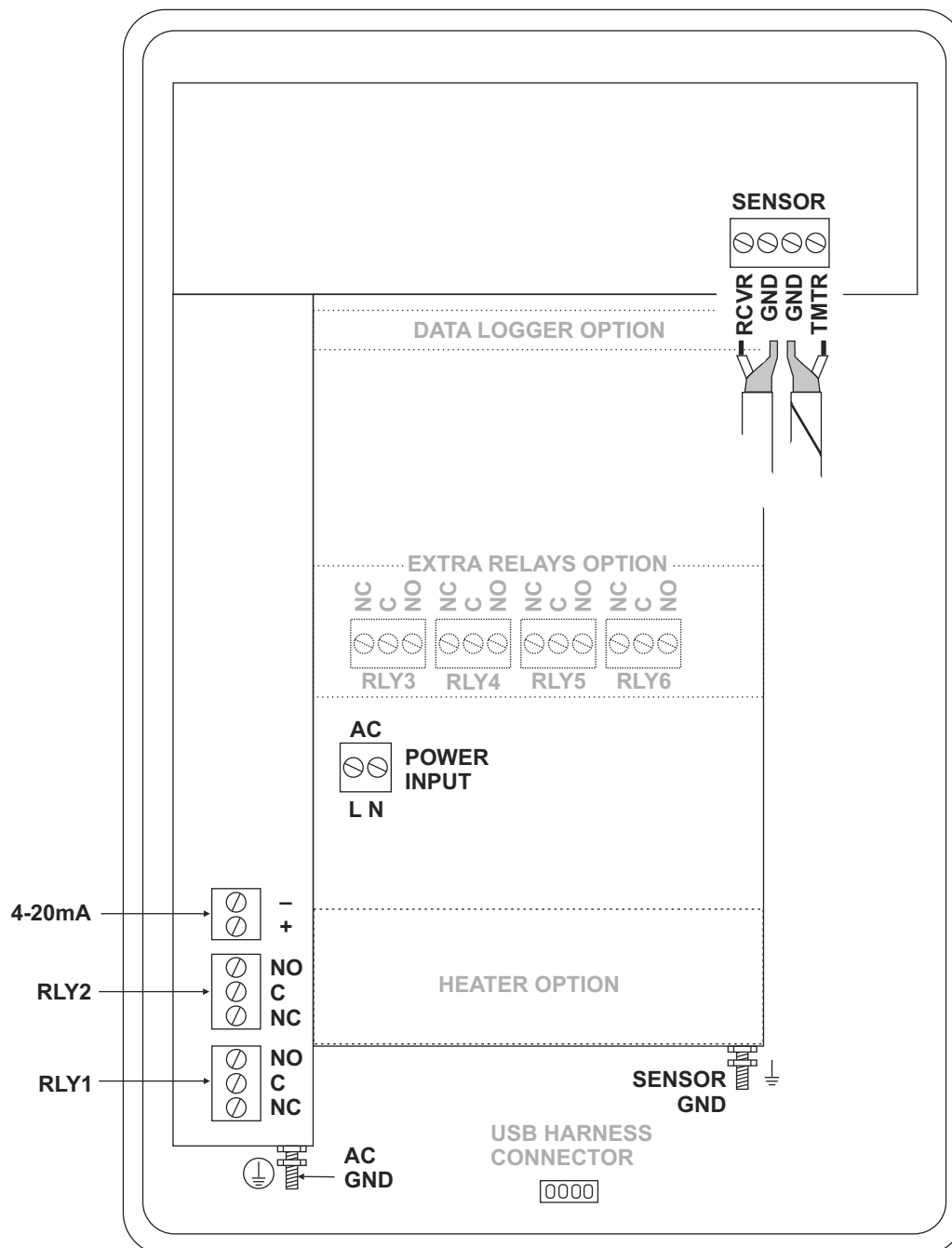


Risk of electric shock. Loosen cover screw to access connections. Only qualified personnel should access connections.

Note: Use of instrumentation over 40°C ambient requires special field wiring.

Note: User replaceable fuse is 2 Amp 250V (T2AL250V).

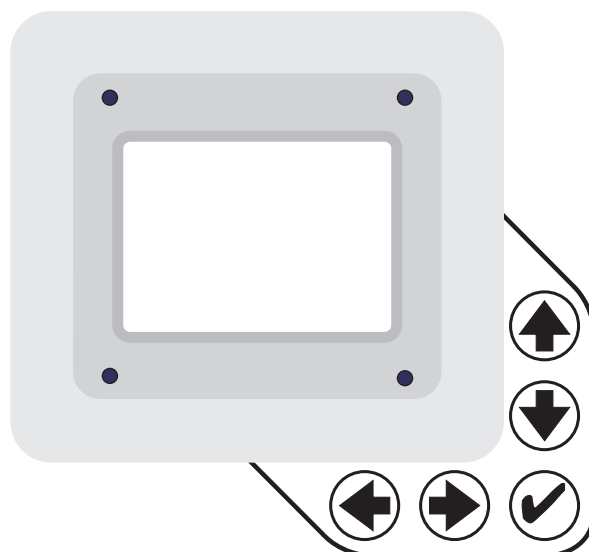
## CONNECTIONS



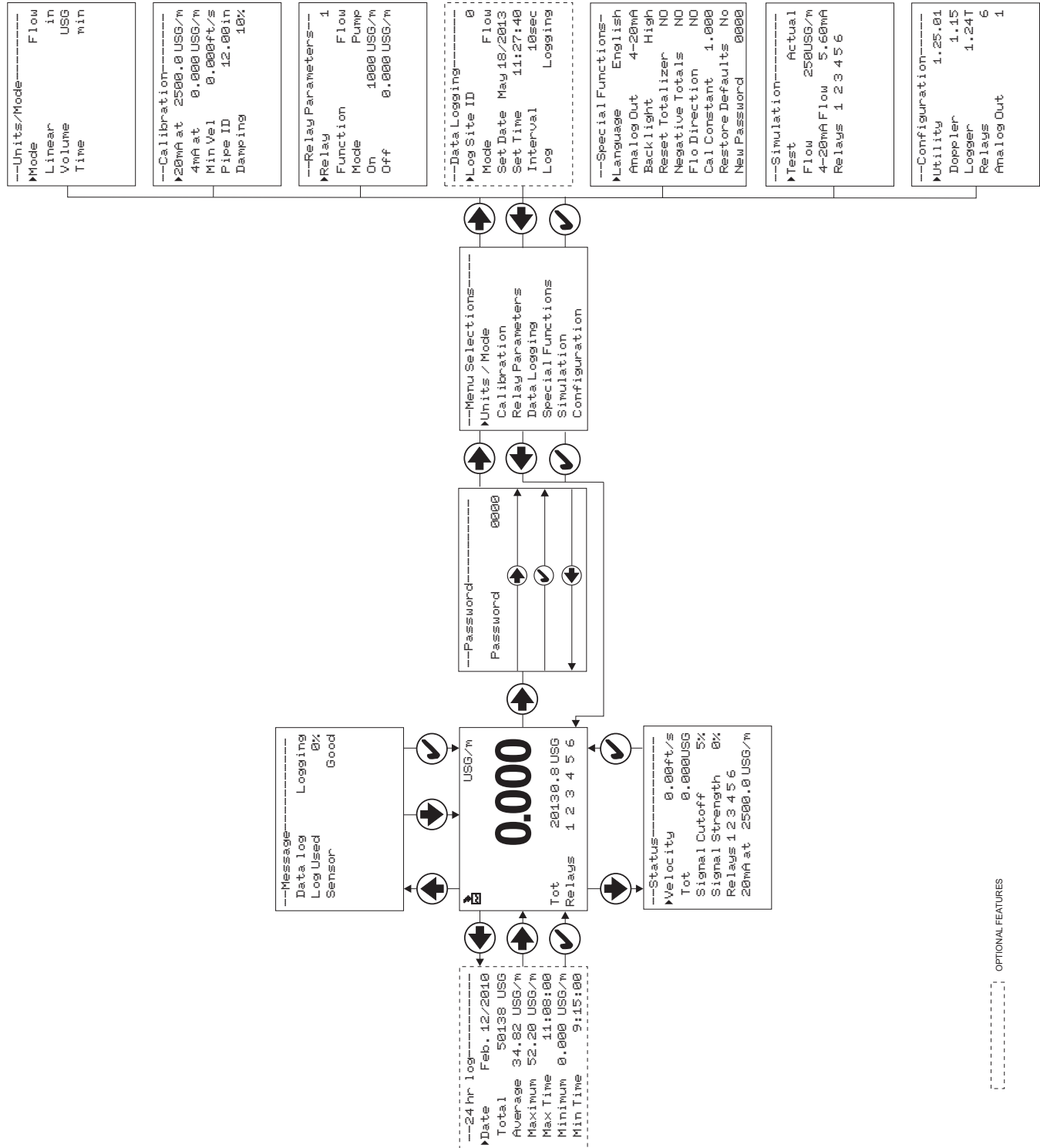
## **KEYPAD SYSTEM**

The following diagram shows the DFM 5.1 menu system. Arrows show the four directions to leave a menu box. Pressing a corresponding keypad arrow will move to the next item in the direction shown. Move the cursor (highlighted) under numerals and increase or decrease numerals with the **↑** and **↓** keys.

To store calibration values permanently (even through power interruptions), press the **✓**.



### CALIBRATION MENU



OPTIONAL FEATURES

## ICONS



1.



2.



1.



2.



1.



2.



3.



4.



Message waiting. Press .

Data logging off.

Data logging on.

USB file download.

File download completed.

Download Error.



```

USG/m
0.000
Tot      20130.8 USG
Relays   1 2 3 4 5 6

```

## MAIN DISPLAY

The main display shows the units selected from the Units/Mode menu, Flow or Velocity rate being measured, TOTALIZER and RELAY states. The DFM 5.1 will start-up with this display.

```

--Message-----
Data log      Logging
Log Used      0%
Sensor        Good

```

## MESSAGE ICON

Press **↑** from the main display to view status of the data logger and error/warning messages provided by the instrument. The Message Icon will appear on the main display if error messages are being generated by the instrument. Press **✓** to return to the main display.

```

--Status-----
▶Velocity      0.00ft/s
Tot            0.000USG
Signal Cutoff   5%
Signal Strength 0%
Relays 1 2 3 4 5 6
20mA at 2500.0 USG/m

```

## STATUS

Press **↓** from the main display to view instrument status. Velocity will be displayed in ft/sec or m/sec.

Tot	Displays the current totalizer reading.
Signal Cutoff	Adjust the setting in percent to suppress flow readings at zero flow when fluid swirling or pipe vibration may cause the instrument to continue reading. Example: Signal Cutoff at 5% will force the display and outputs to zero when signal strength drops below 5%.
Signal Strength	Displays percentage of signal being received by the ultrasonic sensor.
Relays	Energized relays will display as a white character on a black background.
20mA at	Displays the flow rate set as 20mA in the Calibration menu. Press <b>✓</b> to return to the main display.

```
--24 hr log-----
Date      Feb. 12/2010
Total      50138 USG
Average    34.82 USG/m
Maximum    52.20 USG/m
Max Time   11:08:00
Minimum     0.000 USG/m
Min Time    9:15:00
```

## 24 HR LOG (Data Logging option only)

Press **◀** from the main display to view a formatted flow report from instruments with a built-in data logger. Press **↓** to scroll down one day or repeatedly to scroll to a specific date. Up to 365 days can be stored. Newest date will overwrite the oldest. Press **✓** to return to the main display.

```
--Password-----
Password      0000
  →
  ✓
  ←
```

## PASSWORD

The password (a number from 0000 to 9999) prevents unauthorized access to the Calibration menu.

From the main display press the **➡** key to get to **Password**. Factory default password is 0000 and if it has not been changed press the **✓** to proceed to the Menu Selections screen.

If a password is required, press **➡** to place the cursor under the first digit and **↓** or **↑** to set the number, then **➡** to the second digit, etc. Press **➡** or **✓** to proceed to the Menu Selections screen.

A new password can be stored by going to **Special Functions/New Password**.

```
--Units/Mode-----
▶Mode                Flow
Linear              in
Volume             USG
Time               min
```

## UNITS/MODE

From ▶**Mode** press the ➡ and then the ⬆ or ⬇ to select **Flow** or **Velocity**. Flow mode displays the flow rate in engineering units (e.g. gpm, litres/sec, etc.) Press the ✓ to store your selection then the ⬇ to the next menu item and ➡ to enter.

```
--Units/Mode-----
Mode                Flow
▶Linear             in
                  ft
                  m
                  mm
```

From ▶**Linear** press the ➡ key and then the ⬆ or ⬇ to select your units of measurement. Press the ✓ to store your selection.

Press the ⬇ key to move the ▶ symbol to each subsequent menu item and the ✓ to save your selections.

Note: the volume selection "bbl" denotes U.S. oil barrel.

Press ⬅ or ✓ to return to the Menu Selections screen.

```
--Units/Mode-----
▶Volume             USG
                  ft3
                  bbl
                  L
                  m3
                  IMG
                  IG
                  USMG
```

```
--Units/Mode-----
Mode                Flow
Linear              in
Volume             USG
▶Time              sec
                  day
                  hr
                  min
```

```

--Calibration-----
▶20mA at 2500.0 USG/m
4mA at 0.000 USG/m
Min Vel 0.000ft/s
Pipe ID 12.00in
Damping 10%
  
```

## CALIBRATION

Press the **↓** to **▶Calibration** and **➡** to enter. Use **↓** or **↑** to position **▶** before each menu item and **➡** to enter. When settings are completed press **✓** to store and return to the Calibration menu.

**20mA at**  
**(5V Flo)**

Press **➡** then **↓** or **↑** to change the numbers and decimal point. Use this menu to set the corresponding flow rate that will be represented by 20mA analog output. If maximum flow is unknown, enter an estimated flow rate and observe actual flow to determine the correct maximum value. Any velocity or flow rate up to +40 ft/sec (12.2 m/sec) may be selected.

**4mA at**  
**(0V Flo)**

Press **↓** or **↑** to set the flow rate corresponding to 4mA analog output. This setting may be left at zero flow (or velocity or can be raised to any value less than the 20mA setting, or lowered to any velocity or corresponding flow rate down to -40 ft/sec (-12.2 m/sec).

**Min Vel**

Press **➡** and enter a minimum velocity cutoff. Forward and reverse velocities less than **Min Vel** will be forced to zero.

**Pipe ID**

Place the cursor under the digits and then **↓** or **↑** to change the numbers and decimal point. **Pipe ID** should be entered as the exact inside diameter of the pipe where the sensor is mounted. Refer to the Pipe Charts Appendix in this manual for inside diameter of common pipe types and sizes.

**Damping**

Increase damping to stabilize readings under turbulent flow conditions. Decrease for fast response to small changes in flow. Damping is shown in percentage (maximum is 99%). Factory default is 10%.

Press **✓** to return to Menu Selections screen.

```
--Relay Parameters--
►Relay          1
Function        Flow
Mode            Pump
On              1000 USG
Off             0.000 USG
```

## RELAY PARAMETERS

**Relay** Press **➡** and **⬇** or **⬆** to select a corresponding relay number (2 relays are standard, 4 additional are optional).

**Function** Press **⬇** or **⬆** to select **Off**, **Pulse** or **Flow**.

**Flow** Mode Select **Pump**, **Low Alarm** or **Hi Alarm**.

**Pump** mode provides separate On/Off settings where the relay will energize at one flow rate and de-energize at another.

**On** Position the cursor under the numerals and press **⬇** or **⬆** to set digits to the required relay **On** set point.

**Off** set digits to the required **Off** set point.

**Low Alarm** mode relay will energize at a programmable flow rate and remain energized with flow below the set point. When flow rises above the set point, the relay will de-energize.

**Hi Alarm** mode relay will energize at a programmable flow rate and remain energized with flow above the set point. When flow falls below the set point, the relay will de-energize.

**Pulse** Press **⬇** and set digits to the flow volume increment required between relay pulses. Use this feature for remote samplers, chlorinators or totalizers. Minimum time between pulses is 2.25 seconds and pulse duration is 350 milliseconds.

Return to **Relay** and change settings for each relay number.

Press **✓** to return to **Menu Selections**.

## DATA LOGGING (OPTIONAL)

Refer to Options section of this manual.

```
--Special Functions--
▶Language      English
Analog Out     4-20mA
Backlight      High
Reset Totalizer NO
Negative Totals NO
Flo Direction  NO
Cal Constant   1.000
Restore Defaults No
New Password    0000
```

```
--Special Functions--
Language      English
▶Backlight     High
               Medium
               Low
               Key Hi/Lo
               Key High
               Key Med
               Key Low
               Off
```

## SPECIAL FUNCTIONS

Language	Select English, French or Spanish
Analog Out	Select 4-20mA or 0-5V mode for the analog output.
Backlight	Select High, Medium or Low for continuous backlight.  Select Key Hi/Lo for high backlight for 1 minute after a keypress and then Lo backlight until a key is pressed again.  Select Key High, Med or Low for backlight for 1 minute after a keypress and then backlight off until a key is pressed again.
Reset Totalizer	Press <b>➡</b> and select <b>Yes</b> to erase and restart the totalizer at zero.
Negative Totals	Select <b>Yes</b> to have reverse flow readings deducted from the totalizer. Select <b>No</b> to totalize forward flow only and ignore reverse flow.
Flo Direction	Select <b>On</b> to enable flow direction measurement. Select <b>Off</b> to disable flow direction measurement. Select <b>Invert</b> to invert the sense of the flow measurement.
Cal Constant	Scales the velocity reading. Factory value is close to 1.000 for a SE4-A sensor.
Restore Defaults	Select <b>Yes</b> and press <b>✓</b> to erase all user settings and return the instrument to factory default settings.
New Password	Select any number from 0000 to 9999 and press <b>✓</b> . Default setting of 0000 will allow direct access to the calibration menus. Setting of any password greater than 0000 will require the password to be entered to access the calibration menus.

Press **✓** to return to **Menu Selections**.

## **SIMULATION**

```
--Simulation-----  
▶Test           Actual  
Flow           250USG/m  
4-20mA Flow    5.60mA  
Relays 1 2 3 4 5 6
```

Exercises the 4-20mA (0-5V) output, digital display and control relays.

**Test** Select **Maximum** and press ✓ to simulate maximum Flow or Velocity and to output 20mA (5V) to the analog channel.

Select **Minimum** and press ✓ to simulate minimum Flow or Velocity and to output 4mA (0V) to the analog channel.

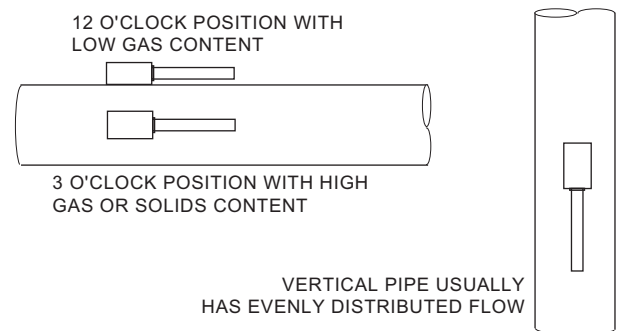
To simulate measurements between minimum and maximum set **Test** to **Actual** and then enter for the flow measurement. The analog output and control relays will respond to the simulated value.

## **SENSOR MOUNTING LOCATION**

The position of the sensor is one of the most important considerations for accurate Doppler flow measurement. The same location guidelines apply to Doppler as most other types of flow meters.

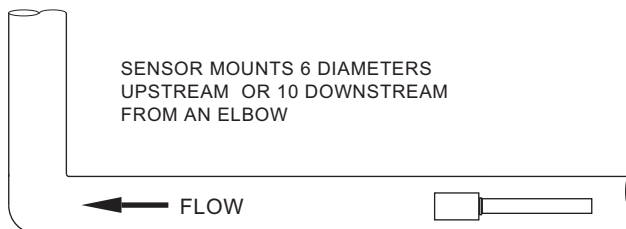
Before permanently mounting a Doppler sensor onsite testing is recommended to determine optimum mounting position. Use the sensor coupling compound (supplied with each Greyline flow meter, or petroleum gel, acoustic compound or electrocardiograph gel). Take several readings around the axis of the pipe and then at several points upstream and downstream from the selected position, checking for consistent readings. Avoid high or low reading areas. Mount the sensor where consistent (average) readings were obtained or continue testing on another pipe section.

**VERTICAL OR HORIZONTAL PIPE** - Vertical pipe runs generally provide evenly distributed flow. On Horizontal pipes and liquids with high concentrations of gas or solids, the sensor should be mounted on the side (3 or 9 o'clock position) to avoid concentrations of gas at the top of the pipe, or solids at the bottom. For liquids with minimal gas bubbles (e.g. potable water) the sensor should be mounted on the top of a horizontal pipe (12 o'clock position) to obtain the best signal strength.



**VELOCITY INCREASING DEVICES:** Generally the sensor must be mounted away from flow disturbances such as valves, pumps, orifice plates, venturis or pipe inlets and discharges which tend to increase flow velocity. Velocity increasing devices often cause cavitation, or rapid release of gas bubbles, and readings both up and downstream may show much higher velocity. As a guideline, mount the sensor at least 20 diameters upstream or 30 diameters downstream from velocity increasing devices.

Required distance from a velocity increasing device will vary in applications depending on the flow velocity and the characteristics of the liquid itself.



**TURBULENCE INCREASING DEVICES:** Elbows, flanged connections and tees tend to introduce desirable conditions of an evenly distributed flow profile with some air or gases entrained in the flow. Sensor mounting 6 pipe diameters upstream and 10 diameters downstream from these disturbances is generally optimum.

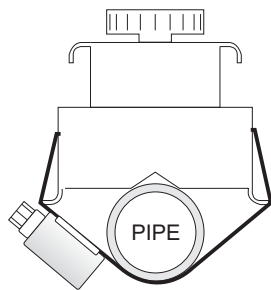
The sensor is designed to mount longitudinally on a straight section of pipe. Do not attempt to mount it on bends, elbows or fittings.



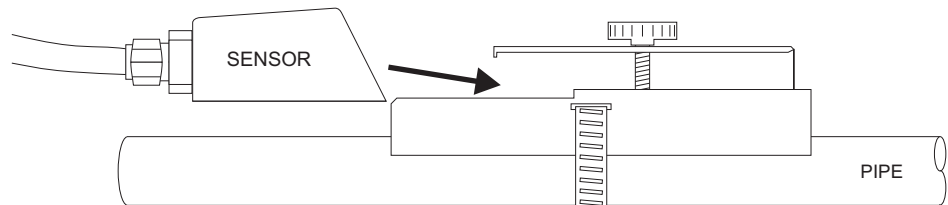
## **SENSOR MOUNTING**

Prepare an area 2" wide by 4" long (50mm x 100mm) for sensor bonding by removing loose paint, scale and rust. The objective of site preparation is to eliminate any discontinuity between the sensor and the pipe wall, which would prevent acoustical coupling.

A PC4 Sensor Mounting Kit is supplied with each Greyline flow meter. It includes recommended coupling compound in a plastic applicator and a stainless steel mounting bracket with adjustable pipe straps.

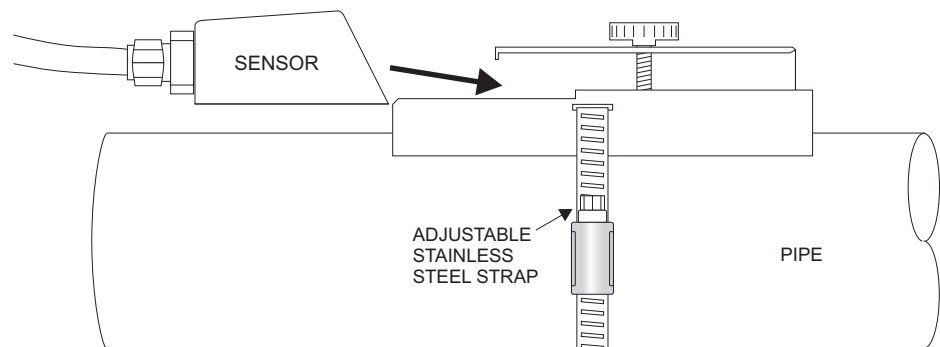
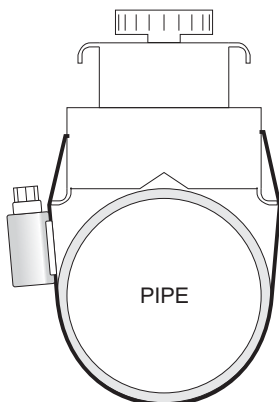


END VIEW



Mount the PC4 pipe clamp as illustrated on pipes 0.6" / 15 mm OD or larger. Stainless steel bands are included for mounting on pipes up to 32" / 81 cm OD.

Additional stainless steel bands (by customer) may be combined to mount on pipes up to 180" / 4.5 m OD.



## **SENSOR COUPLING**

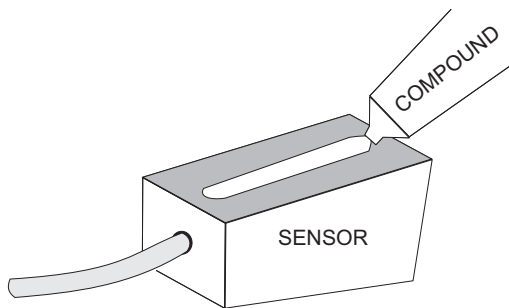
For permanent or temporary bonding, the following are recommended:

- a) Dow Corning silicon compound #4 (supplied)  
Additional supply: order Greyline Option CC
- b) High Temperature compound (supplied with Sensor Option SE3H)  
Additional supply: order Greyline Option AP-1W
- c) Water-based sonic compound: Order Greyline Option CC30
- d) Electrocardiograph gel
- e) Petroleum gel (Vaseline)

The above are arranged in their order of preferred application.

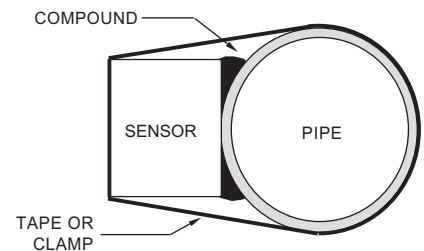
d & e are only good for temporary bonding at room temperature.

**DO NOT USE:** Silicon RTV caulking compound (silicon rubber).



Use the PC4 pipe clamp (supplied) as illustrated above or use a loop of electrical tape for temporary mounting. Apply silicon coupling compound #4 to the coloured face of the sensor. A bead, similar to toothpaste on a toothbrush, is ideal. Do not overtighten (crush the sensor).

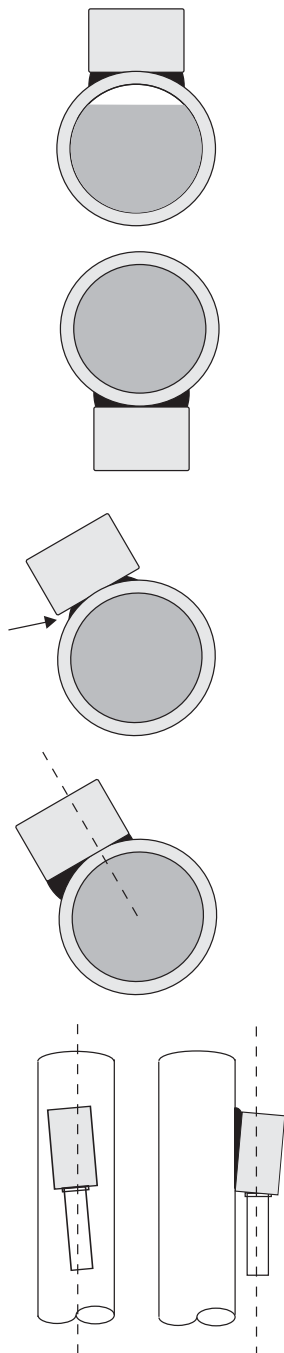
The sensor must be fixed securely to the pipe with coupling material between the sensor face and the pipe. Sensor installation with excessive coupling compound can result in gaps or voids in the coupling and cause errors or loss of signal. Insufficient coupling compound will create similar conditions.



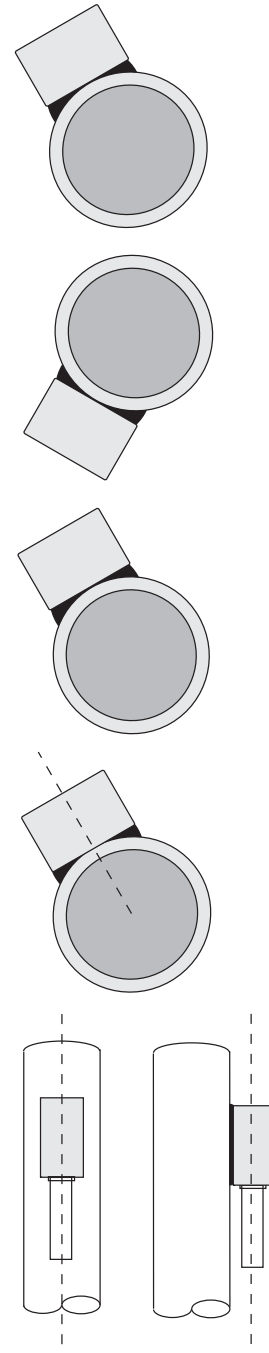
Over time temporary coupling compounds (e.g. Petroleum Gel) may gradually sag away from the sensor resulting in reduced signal strength and finally complete loss of signal. Warm temperatures, moisture and vibration will accelerate this process. Dow Corning Silicone Compound #4 as supplied with the DFM 5.1 (and available from Greyline Instruments) is recommended for semi-permanent installations.

**SENSOR MOUNTING/COUPLING RECOMMENDATIONS**

**BAD**



**GOOD**



## **ENCLOSURE INSTALLATION**

Locate the enclosure within 20 ft (6 m) of the sensor (500 ft -150 m optional). The enclosure can be wall mounted with the four mounting screws (included) or panel mounted with Option PM Panel Mount kit from Greyline Instruments.

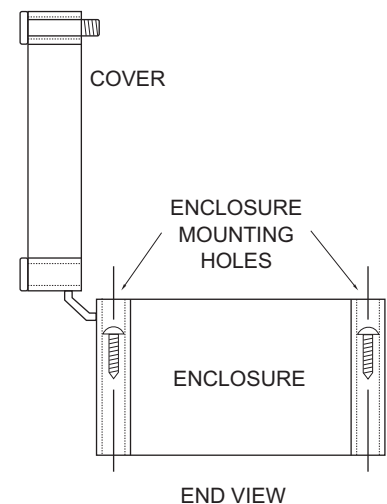
Avoid mounting the enclosure in direct sunlight to protect the electronics from damage due to overheating and condensate. In high humidity atmospheres, or where temperatures fall below freezing, Option TH Enclosure Heater and Thermostat is recommended. Seal conduit entries to prevent moisture from entering enclosure.

### **NEMA4X (IP66) WITH CLEAR COVER**

1. Open hinged enclosure cover.
2. Insert #8 screws (supplied) through the four enclosure mounting holes to secure the enclosure to the wall or mounting stand.

Additional conduit holes can be cut in the bottom of the enclosure when required. Use a hole saw or Greenlee-type hole cutter to cut the required holes.

**DO NOT** make conduit/wiring entries into the top of the enclosure.



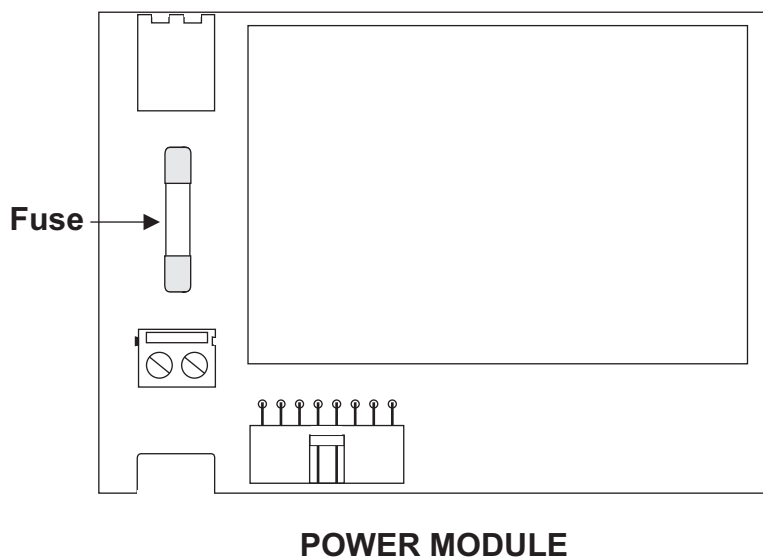
Note: This non-metallic enclosure does not automatically provide grounding between conduit connections. Grounding must be provided as part of the installation. Ground in accordance with the requirements of the National Electrical Code. System grounding is provided by connecting grounding wires from all conduit entries to the steel mounting plate or another point which provides continuity.

## **CLEANING**

Cleaning is not required as a part of normal maintenance.

**FUSE REPLACEMENT**

1. Turn OFF power.
2. Loosen cover screw and open.
3. Remove power module.
4. Locate fuse on Power Board.
5. Replace fuse with 2 AMP/ 250V, 5 x 20mm fuse.
6. Reinstall power module into chassis.



## FIELD TROUBLESHOOTING

Possible Causes:	Corrective Action:
<b>METER READING LOWER THAN EXPECTED</b>	
Calibration Error	<ul style="list-style-type: none"> <li>Review <b>UNITS/MODE</b> menu and <b>Pipe ID</b></li> </ul>
Lower flow rate than expected	<ul style="list-style-type: none"> <li>Investigate pump/valves. Compare velocity with alternate instrument</li> </ul>
Signal not penetrating far enough into the flow stream	<ul style="list-style-type: none"> <li>Relocate sensor closer to elbows or flow disturbances</li> </ul>
Improper mounting of sensor	<ul style="list-style-type: none"> <li>Reinstall Sensor with careful application of Coupling Compound</li> </ul>
Pipe is not full	<ul style="list-style-type: none"> <li>Remount Sensor on vertical pipe</li> </ul>
<b>METER READING WHEN THERE IS NO FLOW</b>	
Vibration on pipe	<ul style="list-style-type: none"> <li>Adjust Status / Signal Cutoff setting</li> <li>Install in another location</li> </ul>
Local electrical noise	<ul style="list-style-type: none"> <li>Ensure all Flowmeter wiring is in METAL conduit and sensor shield is properly grounded.</li> <li>Ensure correct power input Ground connection (&lt;1 ohm resistance).</li> <li>Ensure 4-20mA Shield connected to Instrument Ground stud.</li> </ul>
Cross talk between two or more DFM 5.1 flowmeters on same pipe	<ul style="list-style-type: none"> <li>Refer to Synchronization instructions</li> </ul>
Variable Speed Drive interference	<ul style="list-style-type: none"> <li>Follow Drive manufacturers wiring and Grounding instructions</li> <li>Relocate Flowmeter electronics, Sensor and wiring away from VSD</li> </ul>
Sensor cable connections incorrect or loose	<ul style="list-style-type: none"> <li>Refer to Connections diagram. Disconnect and reconnect sensor cables ensuring that cable is properly inserted into terminals and tightened.</li> </ul>

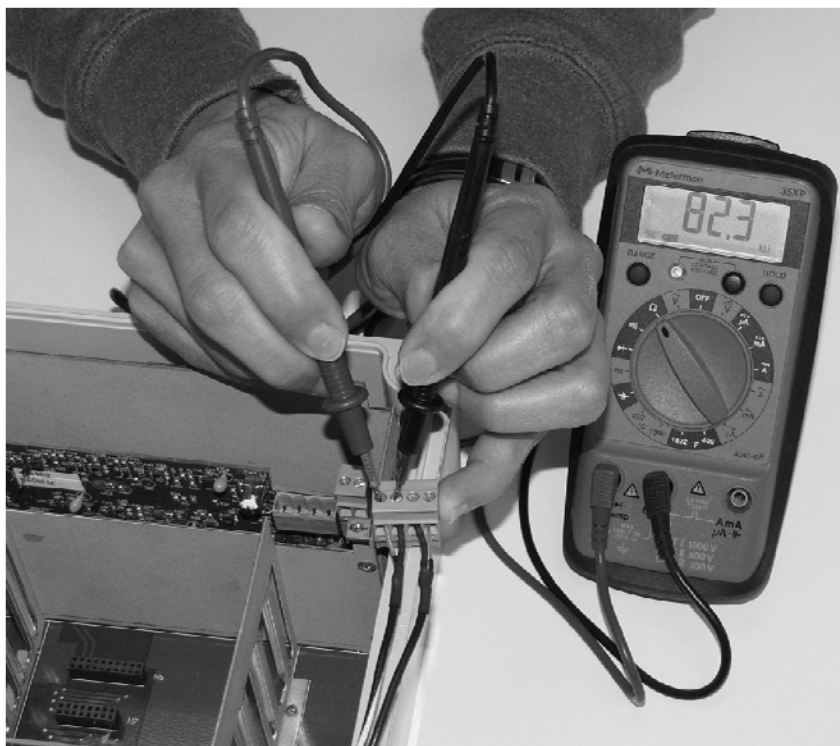
Possible Causes:	Corrective Action:
<b>METER READING ERRATIC</b>	
Sensor mounted too close to valve, pump or elbow	<ul style="list-style-type: none"> <li>Change sensor placement. Recommended 6-10 diameters from elbows, and 30 diameters from pumps, controlling valves, orifice plates, nozzles or open pipe discharge</li> </ul>
<b>NO FLOW INDICATION</b>	
Not enough suspended particles or gases in the fluid	<ul style="list-style-type: none"> <li>Relocate sensor in more turbulent pipe section. Mount sensor at 12 o'clock position on horizontal pipe</li> </ul>
Coupling compound washed out, or sensor loose on pipe	<ul style="list-style-type: none"> <li>Remount sensor</li> <li>Use Dow Corning Silicone #4</li> </ul>
Power interruption. No flow.	<ul style="list-style-type: none"> <li>Check fuse/breaker. Confirm flow</li> </ul>
<b>METER READING TOO HIGH</b>	
Calibration error	<ul style="list-style-type: none"> <li>Review <b>UNITS/MODE</b> menu and <b>Pipe ID</b></li> </ul>
Vibration or noise on the pipeline	<ul style="list-style-type: none"> <li>Install in another location.</li> </ul>
Pipe is not full	<ul style="list-style-type: none"> <li>Remount Sensor on vertical pipe</li> </ul>
Nearby velocity increasing device (pump, valve, orifice plate)	<ul style="list-style-type: none"> <li>Relocate sensor &gt;30 pipe diameters from velocity increasing device</li> </ul>
Local electrical noise	<ul style="list-style-type: none"> <li>Ensure all Flowmeter wiring is in METAL conduit and sensor cable shield is connected to Ground stud</li> </ul>
Variable Speed Drive interference	<ul style="list-style-type: none"> <li>Follow Drive manufacturers wiring and Grounding instructions</li> <li>Relocate Flowmeter electronics, Sensor and wiring away from VSD</li> </ul>

Possible Causes:	Corrective Action:
<b>METER READING DOES NOT TRACK FLOW</b>	
Sensor and GND wires reversed or not properly connected	<ul style="list-style-type: none"> <li>• Check Sensor connections</li> </ul>
Improper AC power input Ground	<ul style="list-style-type: none"> <li>• Use direct connection with 12 AWG wire to nearest Ground pole (&lt;1 ohm resistance).</li> </ul>

## SENSOR CABLE RESISTANCE TEST

Unplug the green sensor terminal from the Doppler board and connect the sensor wires as shown. With a multimeter, perform resistance checks for each set of wires. One single loose terminal may cause false readings.

Test across shield and core of each wire: TMTR (black/white) and RCVR (black). Resistance should be around 82.5K ohms for any cable length. High readings indicate an open circuit and low readings indicate a short or partial short in the sensor cable.





**COMMON QUESTIONS AND ANSWERS**

*The pipe vibrates. Will it affect the flow meter?*

Common vibration frequencies are far lower than the sonic frequencies used by the Greyline flow meter, and will not normally affect accuracy or performance. However, applications where very weak Doppler signal is present (when sensitivity is adjusted to maximum and signal strength is low), accuracy may be affected by pipe vibration, or the flow meter may show readings under no-flow conditions. Attempt to relocate the sensor on a pipe section where vibration is reduced, or arrange pipe mounting brackets to reduce vibration at the sensor mounting location.

*The flow meter must be installed in a high noise environment. Will this affect operation?*

Greyline flow meters are designed to discriminate between environmental noise and the Doppler signal. High noise environments may affect the flow meter's performance where low signal strength and/or low flow velocities are being measured. Relocate the sensor in a more quiet environment if possible.

*Will pipe corrosion affect accuracy of the flow meter?*

Yes. Rust, loose paint etc. must be removed from the outside of the pipe to provide a clean mounting position when installing a Doppler sensor. Severe corrosion/oxidation on the inside of the pipe may prevent the Doppler signal from penetrating into the flow. If the pipe cannot be cleaned, a spool piece (PVC recommended) should be installed for sensor mounting.

*What effect do pipe liners have on the flow meter?*

The air gap between loose insertion liners and the pipe wall prevent the Doppler signal from entering the flow. Better results can be expected with bonded liners such as cement, epoxy or tar, however an on site test is recommended to determine if the application is suitable for a Doppler flow meter.

*Why is Doppler only recommended for liquids containing suspended solids or gases?*

The Doppler sensor transmits sound into the flow stream which must be reflected back to the sensor to indicate flow velocity. Gas bubbles or suspended solids act as reflectors for the Doppler signal. As a guideline, Greyline Doppler flow meters are recommended for liquids containing solids or bubbles with a minimum size of 100 microns and a minimum concentration of 75 ppm. Most applications (except potable, distilled or deionized water) will meet this minimum requirement.

*Can the sensor be submerged in water?*

Yes, for short periods of time or by accident, but it is not recommended for continuous operation. The sensor is constructed to withstand submersion to 10 psi without damage, but external liquid moving in contact with the sensor can be interpreted as flow and cause false readings.

*What is the purpose of the Signal Strength Display?*

Doppler signals of very low strength are not accepted or processed by the instrument. This feature assists in rejection of environmental noise and vibration. Use the display to evaluate signal strength in your application. Strong signals will increase in percentage to a maximum of 100% or greater.

*Can I change the length of the sensor cable?*

Yes. Technological advances in Greyline Doppler design allow cable lengths up to 500 ft (152 m) with no loss of signal strength. Extended cable (Greyline Option DXC) should be installed in rigid or flexible conduit for mechanical protection. Use only Greyline shielded coaxial pair (RG174U) cable. Cable junctions should be made through a terminal block and housed in a watertight metal junction box (Greyline Option DJB). BNC coaxial connectors (TV cable type) are not recommended for cable splices.

*Does the DFM 5.1 require periodic recalibration?*

No. DFM 5.1 calibration does not drift over time. The solid state sensor has no moving parts to wear and affect calibration. The Doppler flow technique generates an ultrasonic signal proportional to the velocity of flow. All Greyline timing/counting circuits use crystal-controlled frequency references to eliminate any drift in the processing circuitry.

***APPLICATIONS HOTLINE***

For applications assistance, advice or information on any Greyline Instrument contact your Sales Representative, write to Greyline or phone the Applications Hotline below:

United States:	Tel: 315-788-9500	Fax: 315-764-0419
Canada:	Tel: 613-938-8956	Fax: 613-938-4857
Toll Free:	888-473-9546	
Email:	info@greyline.com	
Web Site:	www.greyline.com	

**Greyline Instruments Inc.**

Canada  
16456 Sixsmith Drive  
Long Sault, Ont. K0C 1P0

USA:  
105 Water Street  
Massena, NY 13662

## **PRODUCT RETURN PROCEDURE**

Instruments may be returned to Greyline for service or warranty repair.

### **1 Obtain an RMA Number from Greyline -**

Before shipping a product to the factory please contact Greyline by telephone, fax or email to obtain an RMA number (Returned Merchandise Authorization). This ensures fast service and correct billing or credit.

When you contact Greyline please have the following information available:

1. Model number / Software Version
2. Serial number
3. Date of Purchase
4. Reason for return (description of fault or modification required)
5. Your name, company name, address and phone number

### **2 Clean the Sensor/Product -**

**Important: *unclean products will not be serviced and will be returned to the sender at their expense.***

1. Rinse sensor and cable to remove debris.
2. If the sensor has been exposed to sewage, immerse both sensor and cable in a solution of 1 part household bleach (Javex, Clorox etc.) to 20 parts water for 5 minutes. Important: do not immerse open end of sensor cable.
3. Dry with paper towels and pack sensor and cable in a sealed plastic bag.
4. Wipe the outside of the enclosure to remove dirt or deposits.
5. Return to Greyline for service.

### **3 Ship to Greyline -**

After obtaining an RMA number please ship the product to the appropriate address below:

Canadian and International  
Customers:

Greyline Instruments Inc.  
16456 Sixsmith Drive  
Long Sault, Ont. K0C 1P0

RMA#

USA  
Customers:

Greyline Instruments Inc.  
204 150th Avenue  
Madeira Beach, FL 33708

RMA#

## FLOW METER DATA SHEET

<b><i>Greyline Instruments Inc.</i></b> 16456 Sixsmith Dr., Long Sault, Ont. K0C 1P0 Tel: 613-938-8956 / Fax: 613-938-4857 105 Water Street, Massena NY 13662 Tel: 315-788-9500 / Fax: 315-764-0419	<i>Please complete and return this form to Greyline. It is important. We use this information to check our database for performance of Greyline flow meters in similar applications, and to provide advice and recommendations to you. Thanks for your cooperation.</i>
Contact: _____ Title/Dept.: _____ Company: _____ Project: _____ Address: _____ Tel: _____ Fax: _____	
<b><u>SENSOR:</u></b> Model/Type: _____ Cable Length: _____ Elec. Class: _____ Type of Pump: _____ Distance from nearest Pump, Controlling Valve, Orifice or open Discharge: _____	
<b><u>INSTRUMENT:</u></b> Model/Type: _____ Power Input: _____ Calibrated Range: _____ Indication: _____ Operating Temp.: _____ Alarm: _____ Enclosure Class: _____ Pulse/Unit: _____ Elec. Class: _____ Output: _____	
<b><u>SERVICE CONDITIONS:</u></b> Pipe ID: _____ <input type="checkbox"/> Vertical <input type="checkbox"/> Horizontal Pipe Mat'l: _____ % Solids: _____ Fluid: _____ Material Build-up: _____ Oper. Flow: _____ Vibration: _____ Max. Flow: _____ Max. Pressure: _____ Min. Flow: _____ Max. Temp: _____	
Notes / Sketch Pipe Run:	
By: _____ Date: _____	

## LIMITED WARRANTY

---

Greyline Instruments warrants, to the original purchaser, its products to be free from defects in material and workmanship for a period of one year from date of invoice. Greyline will replace or repair, free of charge, any Greyline product if it has been proven to be defective within the warranty period. This warranty does not cover any expenses incurred in the removal and re-installation of the product.

If a product manufactured by Greyline should prove defective within the first year, return it freight prepaid to Greyline Instruments along with a copy of your invoice.

This warranty does not cover damages due to improper installation or handling, acts of nature, or unauthorized service. Modifications to or tampering with any part shall void this warranty. This warranty does not cover any equipment used in connection with the product or consequential damages due to a defect in the product.

All implied warranties are limited to the duration of this warranty. This is the complete warranty by Greyline and no other warranty is valid against Greyline. Some states do not allow limitations on how long an implied warranty lasts or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

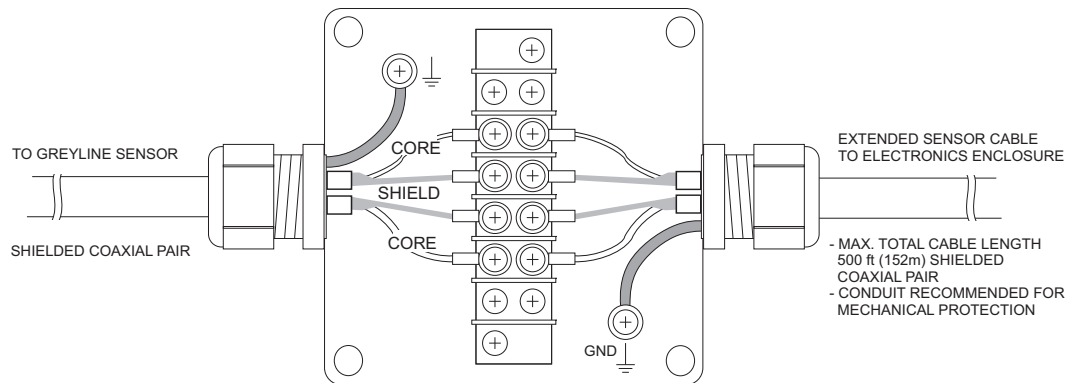
Greyline Instruments Inc.

## **APPENDIX A – OPTIONS**

### **EXTRA SENSOR CABLE (OPTION DXC)**

Each Greyline flow meter includes 20 ft / 6m (or 50 ft / 15 m optional) continuous shielded coaxial pair cable. Additional cable and Cable Junction Box (Option JB2X) may be ordered with the Flow Meter, or the cable may be spliced and extended up to 500 ft (152m) as required during installation. No adjustment is required when the sensor cable is extended or shortened. Use only Greyline shielded coaxial pair (RG174U) cable.

Extended sensor cable should be installed in conduit for mechanical protection. Recommended installation is illustrated below:



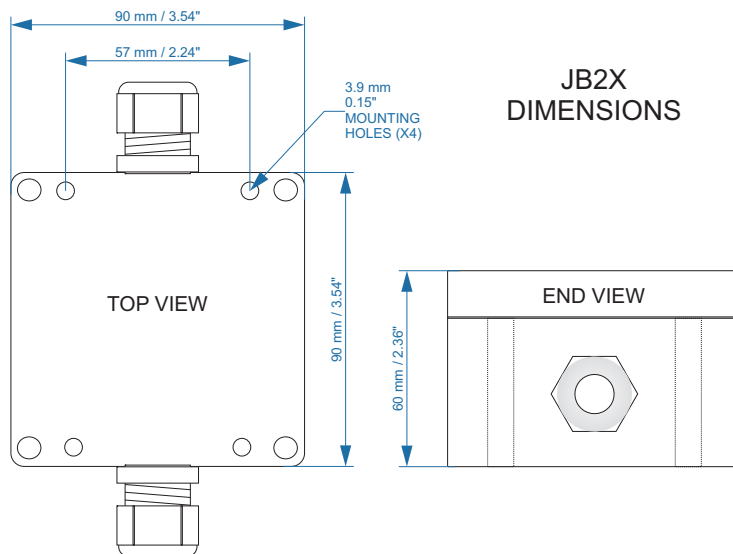
### **COAXIAL CABLE PREPARATION**

DXC Doppler sensor cable can be cut and spliced up to a maximum length of 500 ft (152 m). Cable ends must be prepared as illustrated below.



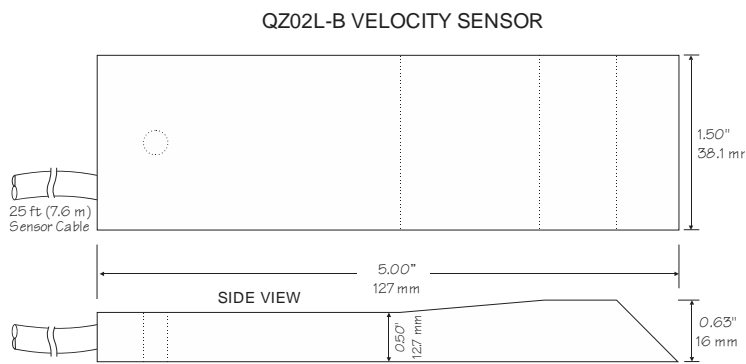
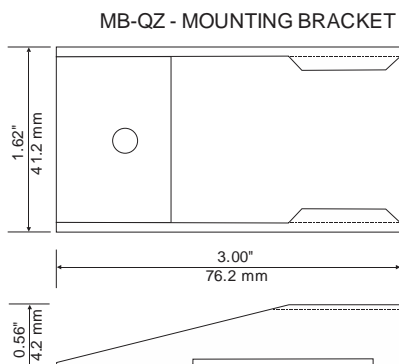
## SENSOR CABLE JUNCTION BOX (OPTION JB2X)

Optional Watertight steel NEMA4 Junction Boxes with terminal strips are available from Greyline Instruments.



## Velocity Sensor QZ02L-B

<b>Minimum Velocity:</b>	0.1 ft/sec (0.03 m/sec)
<b>Maximum Velocity:</b>	20 ft/sec (6.2 m/sec)
<b>Operating Temperature:</b>	5 to 150°F (-15 to 65°C)
<b>Exposed Materials:</b>	PVC, epoxy resin, polyurethane, ultem
<b>Sensor Cable:</b>	25 ft. (7.6 m) submersible polyurethane jacket, shielded, 3 coaxial
<b>Hazardous Rating:</b>	CSA rated Intrinsically Safe Class I, Groups C,D, Class II, Groups E,F,G with optional Intrinsic Safety Barrier





**SENSOR INTRINSIC SAFETY  
(OPTION 2ISB)**

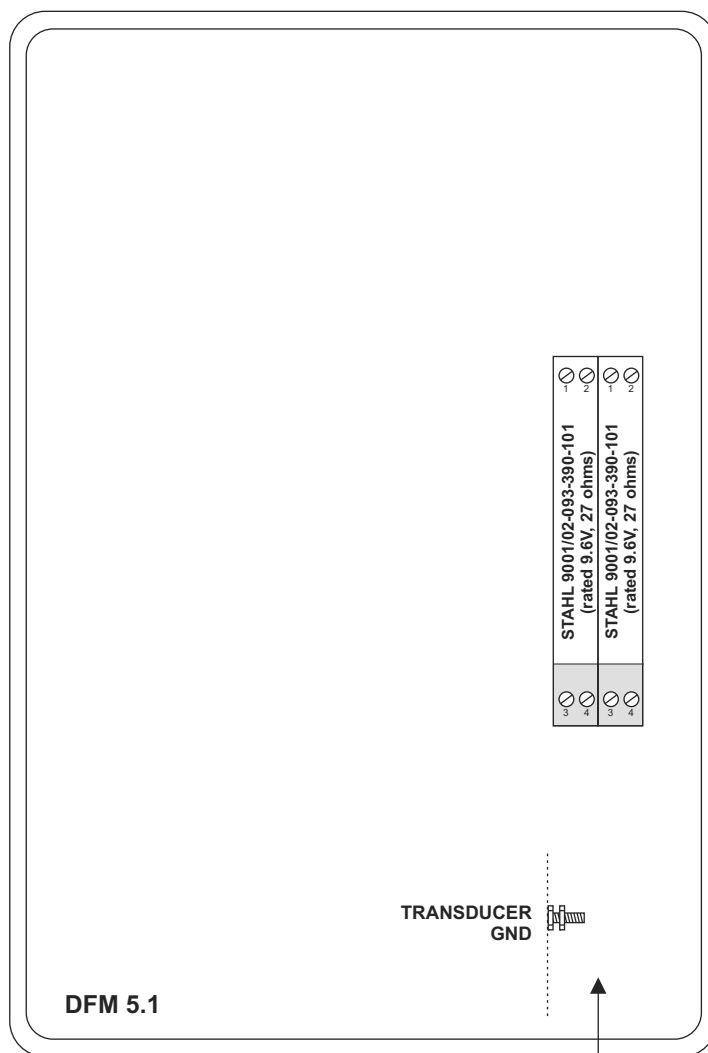
When connected through Intrinsic Safety Barriers, the Greyline Sensor Model SE4 is CSA certified for installation in a hazardous location rated:

Class I, Groups C,D  
Class II, Groups E,F,G  
Class III

Intrinsic Safety Barriers may be ordered with the Greyline instrument and are supplied mounted in the Greyline instrument enclosure. Replacement barrier fuses (Part No. ISB- 011239) may be purchased separately. The instrument enclosure containing the 2ISB Intrinsic Safety Barriers must be installed in a non-hazardous location.

## GN3SPEC-ISB-06

The intrinsic safety barrier assemblies installed in the DFM 5.1 limit the voltage and current supplied to the transducers to the values listed under 'Barrier Specifications'. To safely install a Greyline transducer certified for use in hazardous locations you must refer to the installation drawings/specifications of the certified transducer.



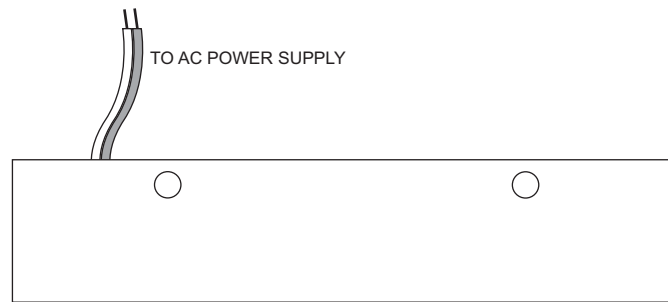
Installed in  
Non-Hazardous Location

### BARRIER SPECIFICATIONS

STAHL BARRIER	System Parameters	Entity Parameters					
		$U_m$	$V_{0c}$	$I_{sc}$	$P_0$	$C_a$	$L_a$
9001/02-093-390-101	9.6V, 27 ohms	250V	9.3V	390mA	906.8mW	4.1 $\mu$ F	0.16mH

## **ENCLOSURE HEATER AND THERMOSTAT - Option TH**

Instruments can be factory-equipped with an Enclosure Heater and Thermostat or the module can be customer-installed. The Thermostat is factory set to turn ON at 40°F (4.5°C) and OFF at 60°F (15.5°C). Power consumption is 15 Watts.



## **ENCLOSURE SUNSCREEN - Option SCR**

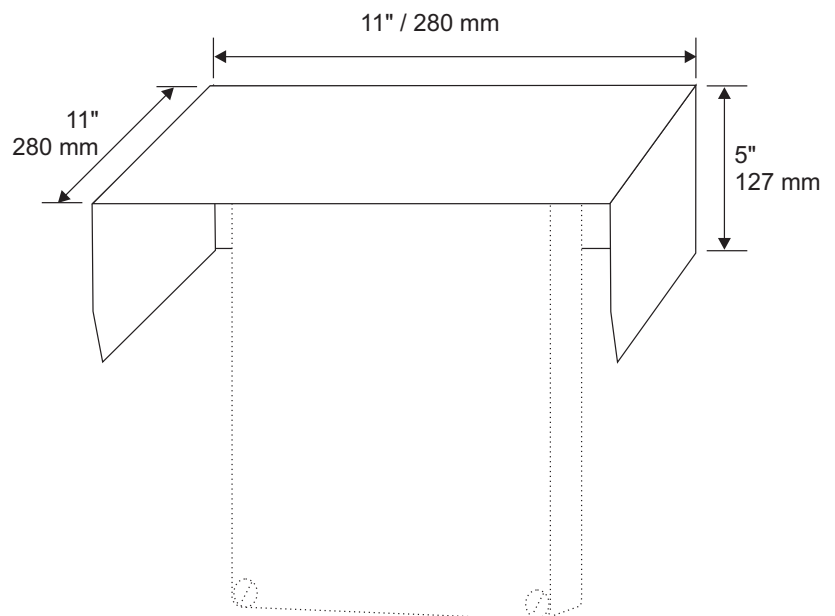
Do not mount instrument electronics in direct sunlight. Overheating will reduce the life of electronic components and condensate may form during the heat/cool cycles and cause electrical shorts.

### Note:

Exposure to direct sunlight can cause overheating and moisture condensation which will reduce the operating life of electronics.

Protect Instruments from direct sunlight with this iridite finished aluminum sun screen (Greyline Option SCR).

Seal conduit entries with caulking compound to further reduce moisture condensation.



## POWER INPUT OPTION 9-32VDC

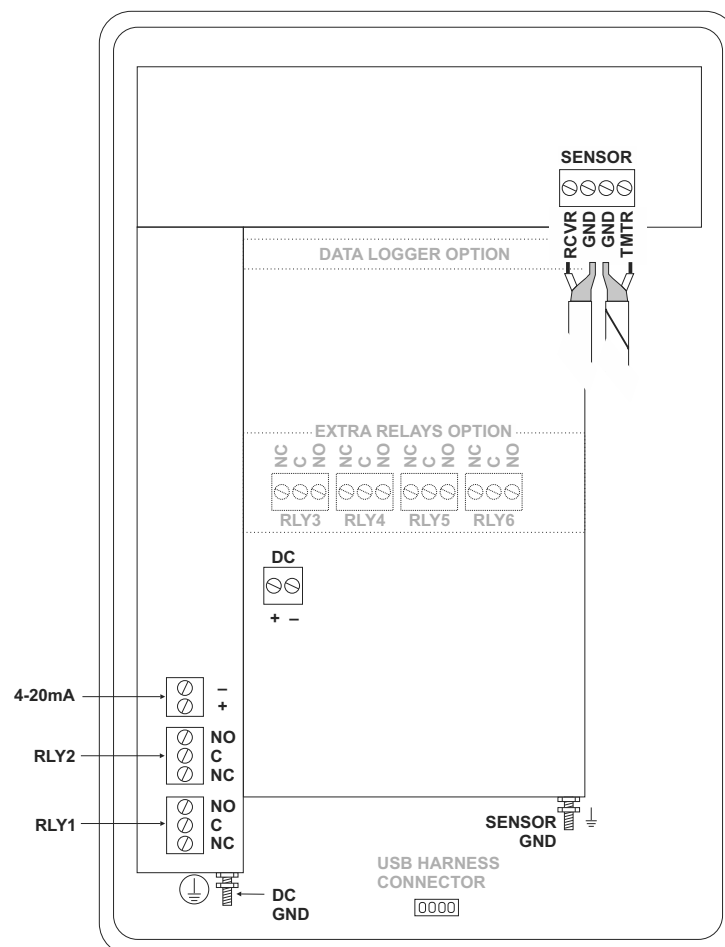
DFM 5.1 Flow Meters may be ordered factory-configured for 9-32VDC power input.

### QUICK BENCH TEST:

Connect Sensor as shown below, then Power. Test operation of the DFM 5.1 by holding the sensor in one hand and rubbing your thumb or fingers briskly across the face (plastic surface) of the sensor. Allow 15 seconds for the DFM 5.1 to process the signal and display a flow value.

### CONNECTIONS:

**POWER INPUT:** Connect 9-32VDC to the + and - terminals. The Power Input GND terminal must be connected to the nearest Ground pole. A 1 amp fuse in line is recommended.



```

--Data Logging-----
▶Log Site ID      00
                  99
Mode              Flow
                  Velocity
Set Date   Feb 18/2008
           Mar 19/2009
Set Time   11:27:40
           12:28:41
Interval   10sec
           60min
           30min
           15min
           10min
           5min
           2min
           1min
           30sec
Log         Stop
           Start
           Delete
  
```

## DATA LOGGING (Optional)

### Setup

Select **Data Logging** from Menu Selections.

**Log Site ID** Enter a number from **00** to **99**. The site ID will become part of the downloaded file name to help distinguish downloads from different instruments. Press **✓** to store the setting.

**Mode** Select **Velocity** (e.g. ft/sec or m/sec). **Flow** (e.g. USGPM or l/sec). Press **✓** to store the setting.

**Set Date** Press **↑** or **↓** to scroll and select Month, Day and Year. Press **✓** to store the setting.

**Set Time** Press **↑** or **↓** to select the current time in Hours, Minutes and Seconds. Press **✓** to store the setting.

**Interval** Press **↑** or **↓** to select the logging interval. Press **✓** to store the setting.

**Log** **Stop**, **Start** or **Delete** the log file.  
Press **↑** or **↓** to **Delete** and **✓** to delete the log file.  
Press **↑** or **↓** to **Start** and **✓** to start the logger.

**Note:** You **MUST** delete old log and start a new log **AFTER** having set changes to **Log Site ID**, **Mode** and/or **Interval** for those changes to be applied to the log file.

## RETRIEVE LOG FILE

Plug a USB Flash Memory Drive (not supplied by Greyline) into the USB output cable from the instrument. The instrument display will show the USB file download icon until the log file is transferred to the memory card and then display file download completed icon. The USB flash drive may be removed.

Download file names will appear in this format:

```

      DFM_ _00A.LOG
      ↑   ↑   ↑
    MODEL TAG DOWNLOAD
  
```

Tag is set according to the **Log Site ID** entered in the instrument **Data Logging** menu.

Download letter will be A for the first download from an instrument. B for the second, then C etc. At the letter Z a - character will appear indicating that the maximum number of downloads for that instrument are on the USB flash drive. Older files can be erased or moved from the flash memory drive or a new memory drive can be used.

### ***OPENING LOG FILES***

Install Greyline Logger on your PC or laptop. Refer to the Help menu in the program for detailed instructions.

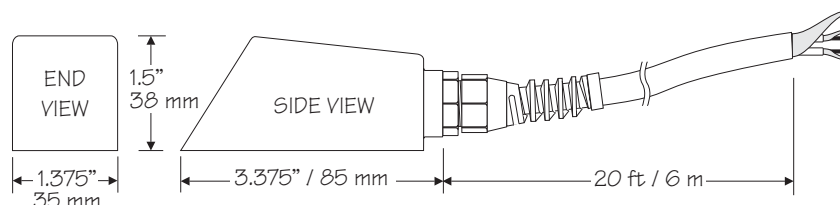
Select File/Open/Instrument Log (.log) to open the log file from your USB flash drive.

### SPECIFICATIONS

<b>Flow Rate Range:</b>	-40 to -0.25 ft/sec, +0.25 to +40 ft/sec (-12.2 to -0.076 m/sec, +0.076 to +12.2 m/sec,) in most applications	
<b>Pipe Size:</b>	Any pipe ID from ½ " to 180" (12.7 mm to 4.5 m)	
<b>Accuracy:</b>	±2% of full scale. Requires solids or bubbles minimum size of 100 microns, minimum concentration 75 ppm. Repeatability: ±0.1%, Linearity ±0.5% of full scale	
<b>Displays:</b>	White, backlit matrix - displays flow rate, totalizer, relay states, operating mode and calibration menu	
<b>Calibration:</b>	built-in 5-key calibrator with English, French or Spanish language selection	
<b>Power Input:</b>	100-240VAC, 50/60Hz, 30 Watts or 9-32VDC, 9 Watts max	
<b>Output:</b>	Isolated 4-20mA (1000 ohm load max.)	
<b>Control Relays:</b>	Qty 2, rated 5 amp 240VAC SPDT, programmable flow alarm and/or proportional pulse	
<b>Enclosure:</b>	watertight, dust tight NEMA4X (IP 66) polycarbonate with a clear shatter-proof face	
<b>Environmental Conditions:</b>	Relative humidity up to 80% -23 to 60°C ambient temperature, maximum 5000 m altitude, pollution degree 4, Installation Category II.	
<b>Sensitivity:</b>	adjustable. Damping: adjustable	
<b>Electrical Surge Protection:</b>	Sensor, 4-20mA output and AC power input	
<b>Approximate Shipping Weight:</b>	10 lbs (4.5 kg)	

### SE4 Doppler Sensor

<b>Minimum Pipe Diameter:</b>	0.5" (12.5 mm) ID, 0.6" (15 mm) OD
<b>Maximum Pipe Diameter:</b>	180" (4.5 m) ID
<b>Operating Temperature:</b>	-40° to 300°F (-40° to 150°C)
<b>Operating Frequency:</b>	640 KHz
<b>Sensor Housing:</b>	Stainless Steel
<b>Sensor Cable:</b>	20 ft. (6 m) shielded coaxial pair (RG174U) Optional 50 ft (15 m) or 100 ft (30 m) continuous
<b>Submersion Rating:</b>	Withstands accidental submersion pressure up to 10 psi (0.7 Bar)



**APPENDIX B - CONVERSION TABLE**

<b>CONVERSION GUIDE</b>		
FROM	TO	MULTIPLY BY
US GALLONS	CUBIC FEET	0.1337
US GALLONS	IMPERIAL GALS	0.8327
US GALLONS	LITRES	3.785
US GALLONS	CUBIC METERS	0.003785
LITRES/SEC	GPM	15.85
LITRES	CUBIC METERS	0.001
BARRELS	US GALLONS	42
BARRELS	IMPERIAL GALS	34.9726
BARRELS	LITRES	158.9886
INCHES	MM	25.4
DEGREES F	DEGREES C	$(^{\circ}\text{F}-32) \times 0.556$
POUNDS	KILOGRAMS	0.453
PSI	BAR	0.0676
FOOT <sup>2</sup>	METER <sup>2</sup>	0.0929

Note: BARRELS are U.S. oil barrels.



## PIPE CHARTS

### Carbon Steel & PVC Pipe

Pipe Size	Pipe O.D.	Standard		Extra Heavy		Dbl. Extra Heavy		Schedule 10		Schedule 20		Schedule 30		Schedule 40	
		I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL
½	.840	.622	.109	.546	.147	.252	.294							.622	.109
¾	1.050	.824	.113	.742	.154	.434	.308							.824	.113
1	1.315	1.049	.133	.957	.179	.599	.358							1.049	.133
1½	1.660	1.380	.140	1.278	.191	.896	.382							1.380	.140
1½	1.900	1.610	.145	1.500	.200	1.100	.400							1.610	.145
2	2.375	2.067	.154	1.939	.218	1.503	.436							2.067	.154
2½	2.875	2.469	.203	2.323	.276	1.771	.552							2.469	.203
3	3.500	3.068	.216	2.900	.300	2.300	.600							3.068	.216
3½	4.000	3.548	.226	3.364	.318	2.728	.636							3.548	.226
4	4.500	4.026	.237	3.826	.337	3.152	.674							4.026	.237
5	5.563	5.047	.258	4.813	.375	4.063	.750							5.047	.258
6	6.625	6.065	.280	5.761	.432	4.897	.864							6.065	.280
8	8.625	7.981	.322	7.625	.500	6.875	.875			8.125	.250	8.071	.277	7.981	.322
10	10.750	10.020	.365	9.750	.500	8.750	1.000			10.250	.250	10.136	.307	10.020	.365
12	12.750	12.000	.375	11.750	.500	10.750	1.000			12.250	.250	12.090	.330	11.938	.406
14	14.000	13.250	.375	13.000	.500			13.500	.250	13.376	.312	13.250	.375	13.124	.438
16	16.000	15.250	.375	15.000	.500			15.500	.250	15.376	.312	15.250	.375	15.000	.500
18	18.000	17.250	.375	17.000	.500			17.500	.250	17.376	.312	17.124	.438	16.876	.562
20	20.000	19.250	.375	19.000	.500			19.500	.250	19.250	.375	19.000	.500	18.814	.593
22	22.000	21.250	.375	21.000	.500			21.500	.250	21.250	.375	21.000	.500		
24	24.000	23.250	.375	23.000	.500			23.500	.250	23.250	.375	22.876	.562	22.626	.687
26	26.000	25.250	.375	25.000	.500			25.376	.312	25.000	.500				
28	28.000	27.250	.375	27.000	.500			27.376	.312	27.000	.500	26.750	.625		
30	30.000	29.250	.375	29.000	.500			29.376	.312	29.000	.500	28.750	.625		
32	32.000	31.250	.375	31.000	.500			31.376	.312	31.000	.500	30.750	.625		
34	34.000	33.250	.375	33.000	.500			33.376	.312	33.000	.500	32.750	.625		
36	36.000	35.250	.375	35.000	.500			35.376	.312	35.000	.500	34.750	.625		
42	42.000	41.250	.375	41.000	.500					41.000	.500	40.750	.625		

### Ductile Iron Pipe - Standard Classes

Size INCH	OUTSIDE DIA. INCH	Class 50		Class 51		Class 52		Class 53		Class 54		Class 55		Class 56		CEMENT LINING	
		WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	**S TD THICKNESS	** DOUBLE THICKNESS
3	3.96			0.25	3.46	0.28	3.40	0.31	3.34	0.34	3.28	0.37	3.22	0.41	3.14		
4	4.80			0.26	4.28	0.29	4.22	0.32	4.16	0.35	4.10	0.38	4.04	0.44	3.93		
6	6.90	0.25	6.40	0.28	6.34	0.31	6.28	0.34	6.22	0.37	6.16	0.40	6.10	0.43	6.04	.125	.250
8	9.05	0.27	8.51	0.30	8.45	0.33	8.39	0.36	8.33	0.39	8.27	0.42	8.21	0.45	8.15		
10	11.10	0.39	10.32	0.32	10.46	0.35	10.40	0.38	10.34	0.41	10.28	0.44	10.22	0.47	10.16		
12	13.20	0.31	12.58	0.34	12.52	0.37	12.46	0.40	12.40	0.43	12.34	0.46	12.28	0.49	12.22		
14	15.30	0.33	14.64	0.36	14.58	0.39	14.52	0.42	14.46	0.45	14.40	0.48	14.34	0.51	14.28		
16	17.40	0.34	16.72	0.37	16.66	0.40	16.60	0.43	16.54	0.46	16.48	0.49	16.42	0.52	16.36		
18	19.50	0.35	18.80	0.38	18.74	0.41	18.68	0.44	18.62	0.47	18.56	0.50	18.50	0.53	18.44	.1875	.375
20	21.60	0.36	20.88	0.39	20.82	0.42	20.76	0.45	20.70	0.48	20.64	0.51	20.58	0.54	20.52		
24	25.80	0.38	25.04	0.41	24.98	0.44	24.92	0.47	24.86	0.50	24.80	0.53	24.74	0.56	24.68		
30	32.00	0.39	31.22	0.43	31.14	0.47	31.06	0.51	30.98	0.55	30.90	0.59	30.82	0.63	30.74		
36	38.30	0.43	37.44	0.48	37.34	0.62	37.06	0.58	37.14	0.63	37.04	0.68	36.94	0.73	36.84		
42	44.50	0.47	43.56	0.53	43.44	0.59	43.32	0.65	43.20	0.71	43.08	0.77	42.96	0.83	42.84	.250	.500
48	50.80	0.51	49.78	0.58	49.64	0.65	49.50	0.72	49.36	0.79	49.22	0.86	49.08	0.93	48.94		
54	57.10	0.57	55.96	0.65	55.80	0.73	55.64	0.81	55.48	0.89	55.32	0.97	55.16	1.05	55.00		

\*\*REDUCE I.D. BY DIMENSION SHOWN

## Stainless Steel, Hastelloy "C" & Titanium Pipe

Pipe Size	Pipe O.D.	Schedule 5 S (a)		Schedule 10 S (a)		Schedule 40 S		Schedule 80 S	
		I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL
½	.840	.710	.065	.674	.083	.622	.109	.546	.147
¾	1.050	.920	.065	.884	.083	.824	.113	.742	.154
1	1.315	1.185	.065	1.097	.109	1.049	.133	.957	.179
1¼	1.660	1.530	.065	1.442	.109	1.380	.140	1.278	.191
1½	1.900	1.770	.065	1.682	.109	1.610	.145	1.500	.200
2	2.375	2.245	.065	2.157	.109	2.067	.154	1.939	.218
2½	2.875	2.709	.083	2.635	.120	2.469	.203	2.323	.276
3	3.500	3.334	.083	3.260	.120	3.068	.216	2.900	.300
3½	4.000	3.834	.083	3.760	.120	3.548	.226	3.364	.318
4	4.500	4.334	.083	4.260	.120	4.026	.237	3.826	.337
5	5.563	5.345	.109	5.295	.134	5.047	.258	4.813	.375
6	6.625	6.407	.109	6.357	.134	6.065	.280	5.761	.432
8	8.625	8.407	.109	8.329	.148	7.981	.322	7.625	.500
10	10.750	10.482	.134	10.420	.165	10.020	.365	9.750	.500
12	12.750	12.438	.156	12.390	.180	12.000	.375	11.750	.500
14	14.000	13.688	.156	13.624	.188				
16	16.000	15.670	.165	15.624	.188				
18	18.000	17.670	.165	17.624	.188				
20	20.000	19.634	.188	19.564	.218				
22	22.000	21.624	.188	21.564	.218				
24	24.000	23.563	.218	23.500	.250				

Pipe Size	Pipe O.D.	Schedule 60		Schedule 80		Schedule 100		Schedule 120		Schedule 140		Schedule 160	
		I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL
½	.840			.546	.147							.466	.187
¾	1.050			.742	.154							.614	.218
1	1.315			.957	.179							.815	.250
1¼	1.660			1.278	.191							1.160	.250
1½	1.900			1.500	.200							1.338	.281
2	2.375			1.939	.218							1.689	.343
2½	2.875			2.323	.276							2.125	.375
3	3.500			2.900	.300							2.624	.438
3½	4.000			3.364	.318								
4	4.500			3.826	.337			3.624	.438			3.438	.531
5	5.563			4.813	.375			4.563	.500			4.313	.625
6	6.625			5.761	.432			5.501	.562			5.189	.718
8	8.625	7.813	.406	7.625	.500	7.439	.593	7.189	.718	7.001	.812	6.813	.906
10	10.750	9.750	.500	9.564	.593	9.314	.718	9.064	.843	8.750	1.000	8.500	1.125
12	12.750	11.626	.562	11.376	.687	11.064	.843	10.750	1.000	10.500	1.125	10.126	1.312
14	14.000	12.814	.593	12.500	.750	12.126	.937	11.814	1.093	11.500	1.250	11.188	1.406
16	16.000	14.688	.656	14.314	.843	13.938	1.031	13.564	1.218	13.124	1.438	12.814	1.593
18	18.000	16.500	.750	16.126	.937	15.688	1.156	15.250	1.375	14.876	1.562	14.438	1.781
20	20.000	18.376	.812	17.938	1.031	17.438	1.281	17.000	1.500	16.500	1.750	16.064	1.968
22	22.000	20.250	.875	19.750	1.125	19.250	1.375	18.750	1.625	18.250	1.875	17.750	2.125
24	24.000	22.064	.968	21.564	1.218	20.938	1.531	20.376	1.812	19.876	2.062	19.314	2.343

## Cast Iron Pipe - ASA Standard

Pipe Size	Pipe O.D.	Class 50		Class 100		Class 150		Class 200		Class 250		Class 300		Class 350	
		WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.	WALL	I.D.
3	3.96	0.32	3.32	0.32	3.32	0.32	3.32	0.32	3.32	0.32	3.32	0.32	3.32	0.32	3.32
4	4.80	0.35	4.10	0.35	4.10	0.35	4.10	0.35	4.10	0.35	4.10	0.35	4.10	0.35	4.10
6	6.90	0.38	6.14	0.38	6.14	0.38	6.14	0.38	6.14	0.38	6.14	0.38	6.14	0.38	6.14
8	9.05	0.41	8.23	0.41	8.23	0.41	8.23	0.41	8.23	0.41	8.23	0.41	8.23	0.41	8.23
10	11.10	0.44	10.22	0.44	10.22	0.44	10.22	0.44	10.22	0.44	10.22	0.48	10.14	0.52	10.06
12	13.20	0.48	12.24	0.48	12.24	0.48	12.24	0.48	12.24	0.52	12.16	0.52	12.16	0.56	12.08
14	15.30	0.48	14.34	0.51	14.28	0.51	14.28	0.55	14.20	0.59	14.12	0.59	14.12	0.64	14.02
16	17.40	0.54	16.32	0.54	16.32	0.54	16.32	0.58	16.24	0.63	16.14	0.68	16.04	0.68	16.04
18	19.50	0.54	18.42	0.58	18.34	0.58	18.34	0.63	18.24	0.68	18.14	0.73	18.04	0.79	17.92
20	21.60	0.57	20.46	0.62	20.36	0.62	20.36	0.67	20.26	0.72	20.16	0.78	20.04	0.84	19.92
24	25.80	0.63	24.54	0.68	24.44	0.73	24.34	0.79	24.22	0.79	24.22	0.85	24.10	0.92	23.96

## Cast Iron Pipe - AWWA Standard

Pipe Size	Class A 100 Ft. 43 PSIG			Class B 200 Ft. 86 PSIG			Class C 300 Ft. 130 PSIG			Class D 400 Ft. 173 PSIG		
	O.D.	WALL	I.D.	O.D.	WALL	I.D.	O.D.	WALL	I.D.	O.D.	WALL	I.D.
3	3.80	0.39	3.02	3.96	0.42	3.12	3.96	0.45	3.06	3.96	0.48	3.00
4	4.80	0.42	3.96	5.00	0.45	4.10	5.00	0.48	4.04	5.00	0.52	3.96
6	6.90	0.44	6.02	7.10	0.48	6.14	7.10	0.51	6.08	7.10	0.55	6.00
8	9.05	0.46	8.13	9.05	0.51	8.03	9.30	0.56	8.18	9.30	0.60	8.10
10	11.10	0.50	10.10	11.10	0.57	9.96	11.40	0.62	10.16	11.40	0.68	10.04
12	13.20	0.54	12.12	13.20	0.62	11.96	13.50	0.68	12.14	13.50	0.75	12.00
14	15.30	0.57	14.16	15.30	0.66	13.98	15.65	0.74	14.17	15.65	0.82	14.01
16	17.40	0.60	16.20	17.40	0.70	16.00	17.80	0.80	16.20	17.80	0.89	16.02
18	19.50	0.64	18.22	19.50	0.75	18.00	19.92	0.87	18.18	19.92	0.96	18.00
20	21.60	0.67	20.26	21.60	0.80	20.00	22.06	0.92	20.22	22.06	1.03	20.00
24	25.80	0.76	24.28	25.80	0.89	24.02	26.32	1.04	24.22	26.32	1.16	24.00
30	31.74	0.88	29.98	32.00	1.03	29.94	32.40	1.20	30.00	32.74	1.37	30.00
36	37.96	0.99	35.98	38.30	1.15	36.00	38.70	1.36	39.98	39.16	1.58	36.00
42	44.20	1.10	42.00	44.50	1.28	41.94	45.10	1.54	42.02	45.58	1.78	42.02
48	50.50	1.26	47.98	50.80	1.42	47.96	51.40	1.71	47.98	51.98	1.96	48.06
54	56.66	1.35	53.96	57.10	1.55	54.00	57.80	1.90	54.00	58.40	2.23	53.94
60	62.80	1.39	60.02	63.40	1.67	60.06	64.20	2.00	60.20	64.82	2.38	60.06
72	75.34	1.62	72.10	76.00	1.95	72.10	76.88	2.39	72.10			
84	87.54	1.72	84.10	88.54	2.22	84.10						

Pipe Size	Class E 500 Ft. 217 PSIG			Class F 600 Ft. 260 PSIG			Class G 700 Ft. 304 PSIG			Class H 800 Ft. 347 PSIG		
	O.D.	WALL	I.D.	O.D.	WALL	I.D.	O.D.	WALL	I.D.	O.D.	WALL	I.D.
6	7.22	0.58	6.06	7.22	0.61	6.00	7.38	0.65	6.08	7.38	0.69	6.00
8	9.42	0.66	8.10	9.42	0.71	8.00	9.60	0.75	8.10	9.60	0.80	8.00
10	11.60	0.74	10.12	11.60	0.80	10.00	11.84	0.86	10.12	11.84	0.92	10.00
12	13.78	0.82	12.14	13.78	0.89	12.00	14.08	0.97	12.14	14.08	1.04	12.00
14	15.98	0.90	14.18	15.98	0.99	14.00	16.32	1.07	14.18	16.32	1.16	14.00
16	18.16	0.98	16.20	18.16	1.08	16.00	18.54	1.18	16.18	18.54	1.27	16.00
18	20.34	1.07	18.20	20.34	1.17	18.00	20.78	1.28	18.22	20.78	1.39	18.00
20	22.54	1.15	20.24	22.54	1.27	20.00	23.02	1.39	20.24	23.02	1.51	20.00
24	26.90	1.31	24.28	26.90	1.45	24.00	27.76	1.75	24.26	27.76	1.88	24.00
30	33.10	1.55	30.00	33.46	1.73	30.00						
36	39.60	1.80	36.00	40.04	2.02	36.00						